

## Enhancing Sell-In and Sell-Out Forecasting Using Ensemble Machine Learning Method

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**Abstract :** Accurate sell-in and sell-out forecasting is a ubiquitous problem in the retail industry. It is an important element of any demand planning activity. As a global food and beverage company, Nestlé has hundreds of products in each geographical location that they operate in. Each product has its sell-in and sell-out time series data, which are forecasted on a weekly and monthly scale for demand and financial planning. To address this challenge, Nestlé Chile in collaboration with Amazon Machine Learning Solutions Lab has developed their in-house solution of using machine learning models for forecasting. Similar products are combined together such that there is one model for each product category. In this way, the models learn from a larger set of data, and there are fewer models to maintain. The solution is scalable to all product categories and is developed to be flexible enough to include any new product or eliminate any existing product in a product category based on requirements. We show how we can use the machine learning development environment on Amazon Web Services (AWS) to explore a set of forecasting models and create business intelligence dashboards that can be used with the existing demand planning tools in Nestlé. We explored recent deep learning networks (DNN), which show promising results for a variety of time series forecasting problems. Specifically, we used a DeepAR autoregressive model that can group similar time series together and provide robust predictions. To further enhance the accuracy of the predictions and include domain-specific knowledge, we designed an ensemble approach using DeepAR and XGBoost regression model. As part of the ensemble approach, we interlinked the sell-out and sell-in information to ensure that a future sell-out influences the current sell-in predictions. Our approach outperforms the benchmark statistical models by more than 50%. The machine learning (ML) pipeline implemented in the cloud is currently being extended for other product categories and is getting adopted by other geomarkets.

**Keywords :** sell-in and sell-out forecasting, demand planning, DeepAR, retail, ensemble machine learning, time-series

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